MONITORING PLAN

PROJECT NO. C/S-20 EAST MUD LAKE

ORIGINAL DATE: May 15, 1995
REVISED DATE: July 23, 1998

Preface

Pursuant to a CWPPRA Task Force decision on April 14, 1998, the original monitoring plan was reduced in scope due to budgetary constraints. Specifically, existing vegetation and SETs will be monitored six times post-construction rather than ten times and feldspar markers will be monitored four times post-construction rather than ten times. Fisheries monitoring was increased to include sampling during non-drawdown year 1999.

Project Description

The East Mud Lake Marsh Management Project area consists of 8,054 ac (3,222 ha) located in the Calcasieu/Sabine Basin in Cameron Parish, Louisiana (figure 1). The project is bounded by Highway 82 to the south, Highway 27 to the west, Magnolia Road to the north and an existing levee and property line near Oyster Bayou to the East (figure 2).

Historically, the East Mud Lake project area has been characterized as brackish marsh (Chabreck 1968 1988) supporting flora and fauna typically adapted to an average salinity of 8 parts per thousand (ppt). Prior to 1960, the south end of Mud Lake contained dense stands of *Ruppia maritima* (widgeon grass). However, hydrologic conditions have changed causing elevated water levels, rapid water level fluctuations, high salinities, and wide salinity fluctuations, which has led to the disappearance of this important submerged aquatic and other emergent wetland vegetation (USDA-SCS 1994). Analysis of aerial photos of the area indicate a marsh loss rate of 76 ac (30.4 ha) per year from 1953 to 1983 (USDA-SCS 1992). Excluding Mud Lake, the land-to open- water ratio has deteriorated from 99:1 in 1953 to 60:40 in 1983. The Wetland Value Assessment for the project area included 3,233 ac (1,293 ha) of vegetated marsh and 4,821 ac (1,928 ha) of open water, of which 2,388 ac (955 ha) of open water were included within Mud Lake. The land-to open-water ratio calculated in the 1992 assessment indicated further marsh deterioration to 57:23, excluding Mud Lake.

Tidal flow into and out of the project area has historically been from the north (Cal/Sab River Basin Study 1993, SCS). Oyster Bayou and Mud Pass provide outlets from the area on the east and south. Fresh water historically entered the area from the west through First and Second Bayous (figure 2). Second Bayou has silted in since 1957 and now provides little or no freshwater flow. First Bayou remains the main source of freshwater introduction into the area. However, much of the fresh water available for introduction through First Bayou is diverted away from the project area by the Highway 27 borrow canal. First Bayou is also experiencing reduced flow because of siltation.

Several human induced hydrologic changes have led to the deterioration of the marsh over the years.

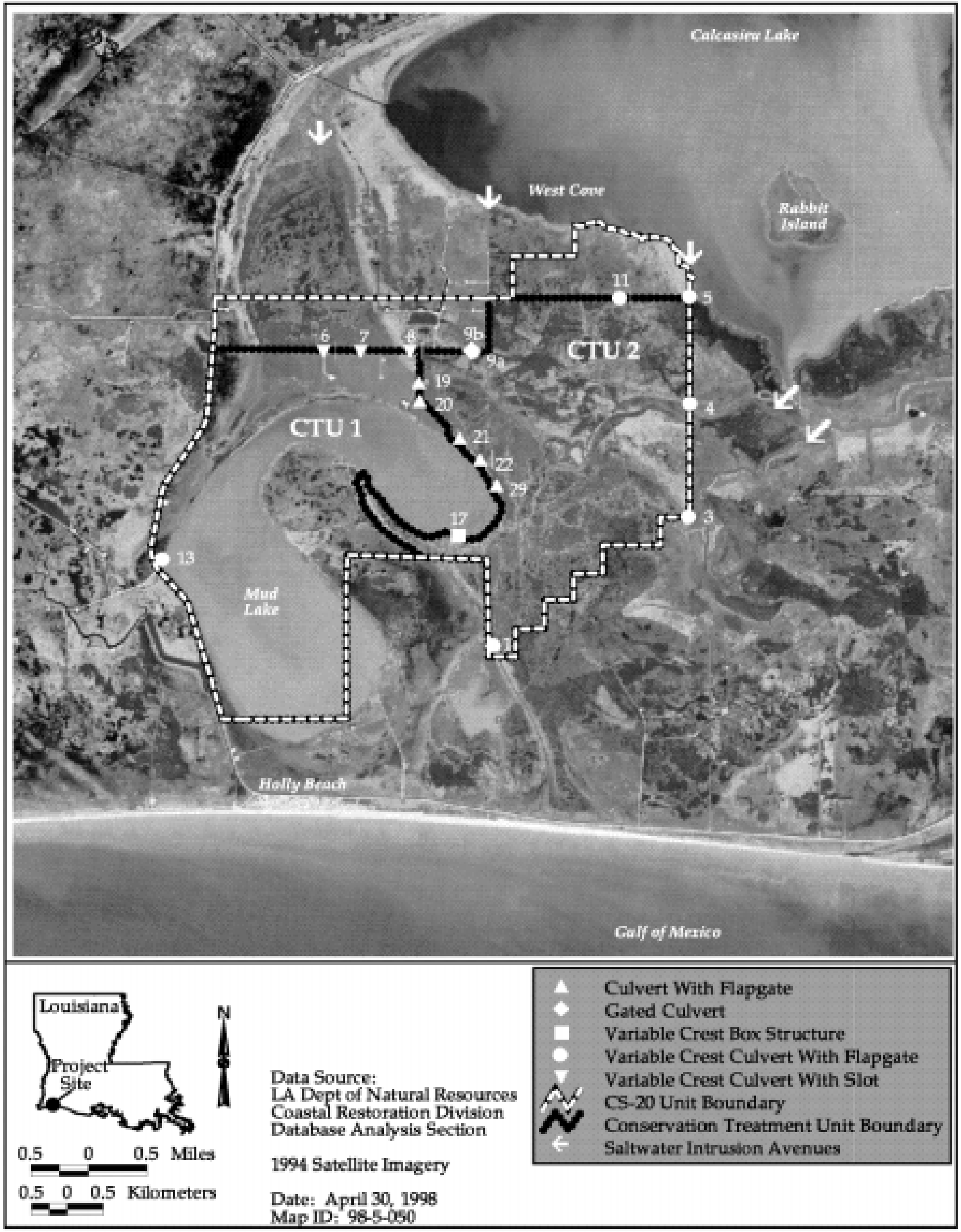

Figure 1. East Mud Lake project area with structures and project features.

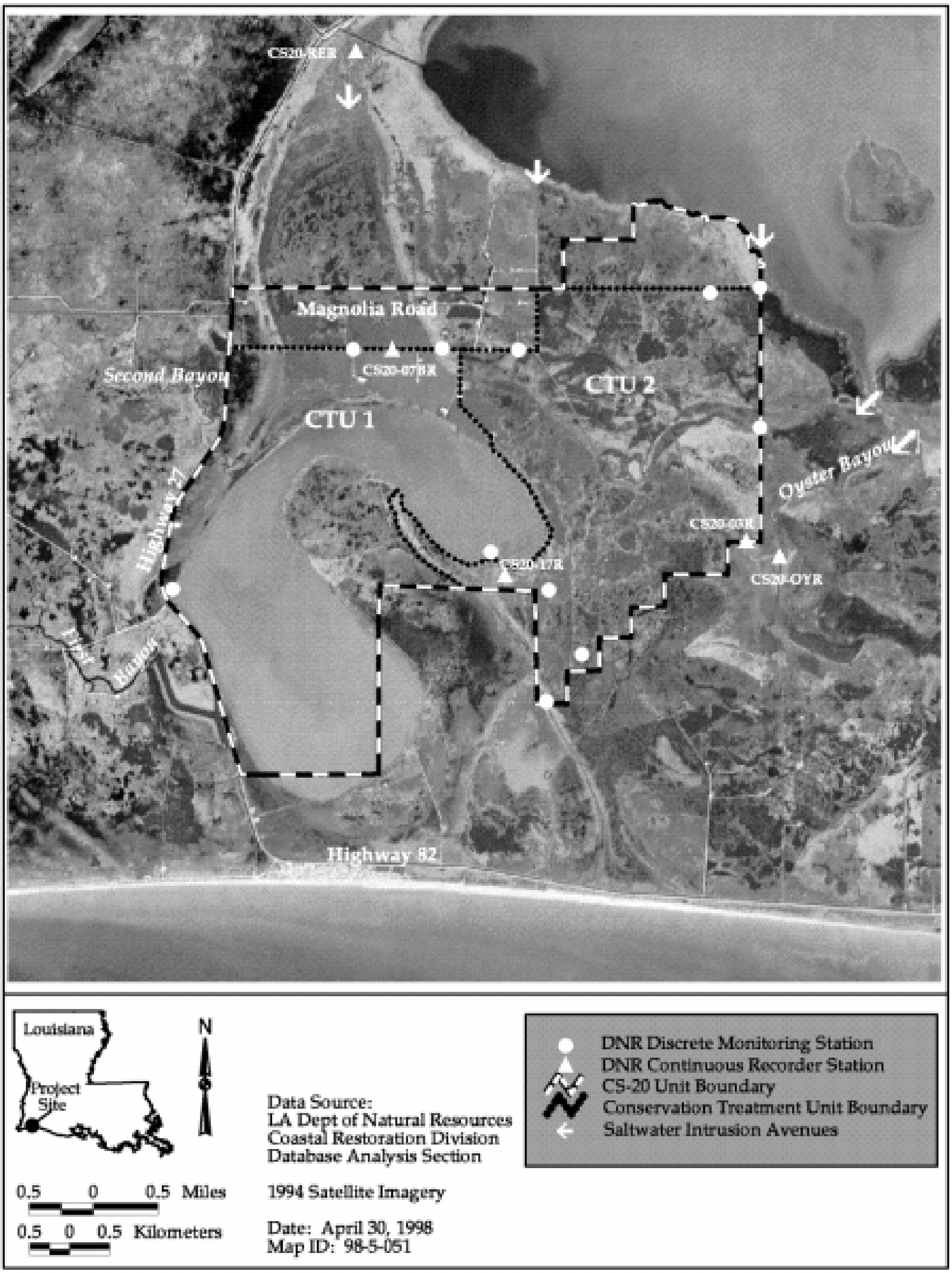

Figure 2. Location of discrete and continuous hydrologic stations at East Mud Lake.

The Calcasieu Ship Channel (CSC), which is one mi east of the project area, was first constructed in 1874 and redredged in 1951 and 1968 to a final width of 400 ft (122 m) and a depth of 40 ft (12.2 m) (USDA-SCS, 1993). Connected hydrologically to Mud Lake by West Cove and East Mud Lake wetlands, the CSC provides an avenue for extreme salinities (4 - 32 ppt) and rapid water movement, which increases turbidity and scouring within the project area. The construction of Highway 27 to the west and Highway 82 to the south have caused decreased drainage from the western and southern areas of the project.

Another problem associated with the project area is excessive water levels over the surface of the marsh for prolonged periods. These sustained high-water levels lead to "ponding," resulting in the deterioration of the vegetation (USDA-SCS 1994). The project addresses these problems through increasing the total number of outlets for the area. The subsidence rate and sea level rise has led to a 0.25 in (0.6 cm) per year water level increase from 1942 to 1988 (Penland et al 1989).

The East Mud Lake Project is designed to reduce wetland degradation by reducing rapid fluctuations in water and salinity levels and prolonged periods of marsh inundation in the project area and by enhancing regeneration of desired emergent and submergent vegetation. This project will increase vegetative occurrence by reducing salinity-induced stress and alleviating excessive water levels while not creating tidal scour problems (Louisiana Coastal Wetlands Conservation and Restoration Priority List 1992).

The project area is divided into two Conservation Treatment Units (CTUs) that will be managed independently and will be separated hydrologically. CTU #1 contains Mud Lake and will be managed passively. Structures and features present in this unit consist of shoreline repair, vegetative plantings, earthen plugs, culverts with flapgates and variable crest culverts. CTU #2 will be actively managed for drawdown capabilities in order to encourage shallow areas to revert to emergent vegetation (figure 2).

The East Mud Lake project involves installing and maintaining water control structures, repairing and constructing levees, and planting vegetation, as components of a marsh management plan for the two CTUs that make up the project area. The structures are designed to reduce the extreme fluctuations in salinity and water levels, while at the same time providing adequate water flow. The structures will help to create a hydrology conducive to the establishment of brackish emergent and submergent vegetation, thereby minimizing marsh deterioration. Vegetative plantings will aid in reverting shallow, open waters less than 0.5 ft (0.15 m) deep to emergent marsh. The vegetative plantings will also help stabilize and protect eroding shorelines.

The types and numbers of structures and features of the project are as follows:

1.	Variable Crest Culverts with Flapgates	6
2.	Variable Crest Culverts With Slots	3
3.	Gated Culvert	1
4.	Culverts with Flapgates	5

5. Variable Crest Box Structure 1
6. Earthen Plugs 2
7. Shoreline Repair 2
(Total = 25,153 cubic ft [712.3 m^3] of dredged material)
8. Levee Repair 1
(66,461 cu yds [50,816 m^3] of dredged material needed to shore up the step levee on the north, east, and southeast sides of CTU #2)

<u>Project Objectives</u>

1. Prevent wetland degradation in the project area by reducing vegetative stress, thereby improving the abundance of emergent and submergent vegetation. This will be achieved through hydrologic structural management to reduce water levels and salinities.

2. Stabilize shoreline of Mud Lake through vegetative plantings.

<u>Specific Goals</u>

The following goals will contribute to the evaluation of the above objectives:

1. Decrease rate of marsh loss.

2. Increase vegetative cover along shoreline of East Mud Lake.

3. Increase coverage of emergent vegetation in shallow, open- water areas.

4. Increase abundance of vegetation in presently vegetated portions of project area.

5. Reduce water-level and salinity fluctuations to within target ranges for brackish vegetation. Target range for salinities is less than or equal to 15 ppt and 6 in. below marsh level to 2 in. above marsh level for water levels.

6. Decrease duration and frequency of flooding over marsh.

7. Decrease mean salinity in Conservation Treatment Unit #2.

8. Increase accretion in Conservation Treatment Unit #2.

<u>Additional Monitoring Needs</u>

1. Maintain fisheries abundance. This is not a specific goal as addressed in the

project documentation. However, due to concerns regarding potential fishery impacts, it has been included in the monitoring plan.

Reference Area

The importance of using appropriate reference areas cannot be overemphasized. Monitoring on both project and reference areas provides a means to achieve statistically valid comparisons, and is therefore the most effective means of evaluating project success. The evaluation of sites was based on the criteria that both project and reference areas have a similar vegetative community, soil type, and hydrology. The project area is classified as brackish marsh (Chabreck and Linscombe 1988) and contains mainly the organic Creole and Bancker soils (Natural Resource Conservation Service n.d.). There are several different components of this marsh management project that occur in areas of dissimilar hydrological influences.

The area east of the project area Conservation Treatment Unit #2, between the Calcasieu Ship Channel, Oyster Lake and Mud Bayou, was selected as the best reference area for all monitoring elements (figure 1). Criteria including hydrological influences, soil, and vegetation types were analyzed in the selection for comparability of data between the reference area and the project area. Both the project area and this reference area are classified as brackish marsh (Chabreck and Linscombe 1988) and contain mainly the organic Bancker and Creole soils (Natural Resource Conservation Service n.d.). Both areas are directly influenced hydrologically by the Calcasieu Ship Channel and are dominated by *Spartina patens* (marshhay cordgrass). The proposed reference area will be used in the evaluation of the vegetative, accretion, water level, salinity, fisheries, and soil monitoring elements. A proportional number of monitoring stations will be used within the reference area. This proposed reference area is located outside the area for which landrights have been obtained. If landrights cannot be obtained for this area, an area north of Magnolia Road will serve as the reference area.

The area north of Magnolia Road is a suitable reference area for the monitoring of water and salinity levels (figure 1). Both the project area and this reference area are classified as brackish marsh (Chabreck and Linscombe 1988) and both contain mainly the organic Bancker and Creole soils (Natural Resource Conservation Service, In Press). Both areas are influenced hydrologically by the Calcasieu Ship Channel and Calcasieu Lake through West Cove Canal. A proportional number of salinity and water level monitoring stations will be used within the reference area.

The area north of Magnolia Road may not be as suitable for the remaining monitoring elements. Therefore, any data collected will be evaluated to determine the suitability of this area as a reference area for all monitoring elements. If this area is used, a proportional number of vegetative and soil sample stations will also be included in the reference area.

Aerial photography for the habitat mapping monitoring element will be flown for both project and reference area.

Monitoring Elements

The following monitoring elements will provide the information necessary to evaluate the specific goals listed above:

1. Habitat Mapping — To document vegetated and nonvegetated areas, color infrared aerial photography (1:12,000 scale with ground controls) will be obtained. The photography will be georectified, photointerpreted, mapped, and analyzed with GIS by the National Wetland Research Center (NWRC) standard operating procedures documented in Steyer et al. (1995). The photography will be obtained in 1994 (pre-construction), and in 2000, 2006, and 2012 (post-construction).

2. Vegetative Plantings — The general condition of the vegetative plantings will be documented by monitoring a 5% sample of the plantings from each of the planting groups, using sampling plots. Each sampling plot will consist of 16 plantings, two rows with eight plants (2x 8 plant plots) with a labelled PVC marker pole beside one of the four corner plants to mark the location of the plot. Survival will be determined as a percentage of the number of live plants to the number planted (% survival = no. plant / no. planted x 100), after Mendelssohn et al. (1991). In addition, a 1-m^2 plot centered around the corner plant with the marker pole for each plot will be sampled for species composition, as percent cover by species. To document the establishment of the vegetation, the plantings will be monitored at 1 mo, 6 mos, and 1 yr after planting, and in 2000, 2003, 2006, 2009, and 2012 or until plants become indistinguishable. Vegetative plantings will occur along the shoreline of East Mud Lake and interior marsh of CTU #2. Exact stations to be sampled will be determined by choosing 5% of the plant numbers for sampling plots using a random numbers table. This will be done once the planting plans are available. Shoreline changes in areas of vegetative plantings will be monitored by measuring the distance from the vegetative plots to the shoreline at times of vegetation sampling.

3. Existing Vegetation — 25 sampling stations will be located in CTU #2 and 10 stations will be located in the reference area to document condition of existing vegetation over the project life. Sites will be chosen by a systematic transect pattern in which 5 transect lines will be drawn in a northwest to southeast configuration from the Calcasieu Lake shoreline. Five stations will be chosen uniformly across each transect line to obtain an even distribution of stations throughout the marsh (figure 2). A finalized station map will be completed following a site visit to the

area to establish the permanent plots. Percent cover, heights of dominant plants, and species composition will be documented in 1.0 m^2 plots marked with 2 corner poles to allow revisiting over time. Descriptive observations of submergent vegetation will be noted during monitoring of emergent vegetation. Sites will be sampled in 1995 (pre-construction), and in 1997, 1999, 2003, 2006, 2009, and 2012 post-construction.

4. Water level — To monitor hydrologic conditions within the project and reference areas, water levels will be recorded one time a month at 18 staff gauge locations. Four continuous recorders have been placed inside the project area and two recorders have been placed in the reference areas, one north of Magnolia Road and one east of the project area. Staff gauges will be placed near structures inside and outside of the project area (figure 3). Both the staff gauges and the continuous recorder sondes will be surveyed to obtain a relationship to marsh level for statistical analysis. Water-level data will be used to document frequency, duration, and range of marsh inundation. Water level data will be collected every year from 1995-2014.

5. Salinity — To monitor hydrologic conditions within the project and reference areas, salinity readings will be recorded once a month at permanent stations (figure 2). Two continuous recorders have been placed inside the project area and two recorders have been placed in the reference areas, one north of Magnolia Road and one east of the project area. Additional continuous recorder sondes may be deployed and/or discrete stations added after adequate data are available to perform a power analysis. Salinity data will be collected every year from 1995-2014.

6. Soil Characteristics — Soil samples will be collected and analyzed to determine grain size, % organic, bulk density, and soil salinity. Samples will be taken at the 25 existing vegetation stations within CTU #2 and 10 stations within CTU #2 reference area once during pre-construction (1996), and in 1999, 2006, and 2012.

7. Accretion — Accretion will be documented in CTU #2 using 2 Feldspar marker horizon plots per station placed adjacent to the 20 existing vegetation stations as well as 20 reference stations (Knauss and Cahoon 1990). Also, 12 Sediment Erosion Table (SET) (Steyer et al. 1995) stations will be established at 2 stations on each of the 5 transects in the project area and 1 station on each of the transects of the reference area

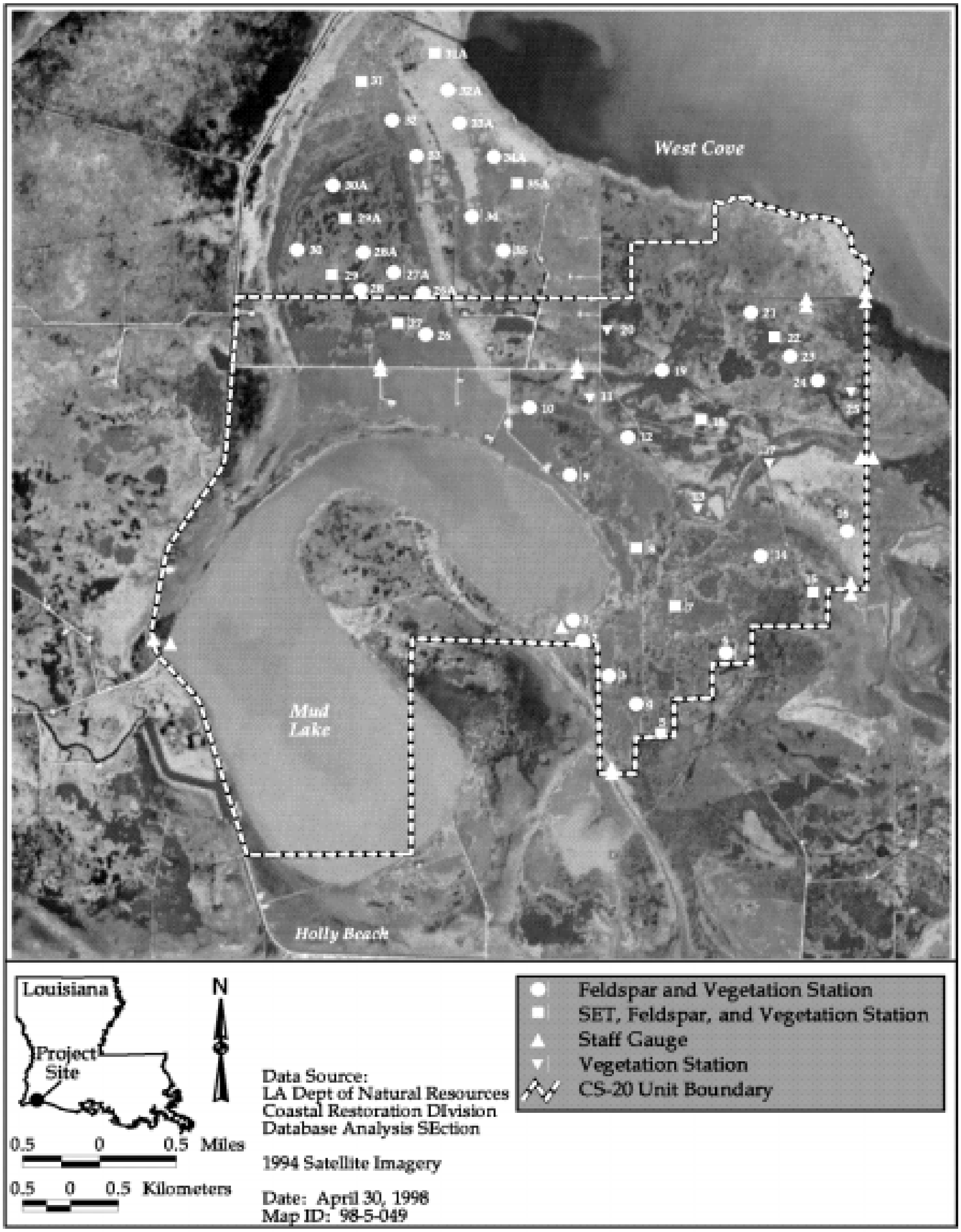

Figure 3. Location of vegetation, feldspar, and SET monitoring stations at East Mud Lake.

in the proximity of the feldspar horizon markers. Feldspar plots will be sampled once during preconstruction, and in 1996, 1997, 1998, 2006, and 2012. SET stations will be sampled in 1996, 1997, 1998, 2003, 2006, 2009, and 2012.

8. Fisheries — Fisheries monitoring will be conducted one time preconstruction (1995) and three times a year during the two years of drawdown of the project after construction in years 1996 and 1997, and one non-drawdown year in 1999. Sampling periods will occur prior to the closing of the gates for the drawdown, late spring, and in the fall at times when the water level is at or below marsh elevation to eliminate emergent marsh as a habitat type to be sampled. Samples will be randomly selected in each area without regard to habitat then the data will be used to estimate both animal densities and habitat coverage for the project and the reference area. Each sampling event will include 30 throw trap (Kushlan 1981) samples for CTU #2 and 30 throw trap samples for the Oyster Lake reference area. Analysis conducted on the samples will include species composition, number of each species per sample, size of animals, and dry weight or biomass of dominant species. Station locations will be added to the map after a site visit to the area for fisheries has been conducted.

<u>Anticipated Statistical Analyses and Hypotheses</u>

The following hypotheses correspond with the monitoring elements above and will be used to evaluate the accomplishment of the project goals. If the null hypothesis is not rejected, possible negative effects will be examined.

1. Descriptive and summary statistics will be used on both historical data and data collected post-project implementation to assess changes in marsh loss rates over time and to assess whether the post-project marsh loss rate deviates from the expected "future without project" condition. Descriptive and summary statistics will be used to compare annual marsh loss rates in the project area with that of the reference area.

   Goal: Decrease rate of marsh loss.

2. The success of the vegetative plantings will be determined by analyses of descriptive statistics. These elements will be examined utilizing ANOVAs to monitor the success or failure of the plantings.

   Goal: Increase vegetative cover along shoreline of East Mud Lake.

Hypothesis:

H_0: Post planting vegetative cover along the shoreline at time point j will not be more than vegetative cover at time point i within the experimental area.

H_a: Post planting vegetative cover along the shoreline at time point j will be more than vegetative cover at time point i within the experimental area.

Goal: Increase vegetative cover in CTU #2.

Hypothesis:

H_0: Post planting vegetative cover within experimental area CTU #2 at time point j will not be more than vegetative cover within experimental area at time point i.

H_a: Post planting vegetative cover within experimental area CTU #2 at time point j will be more than vegetative cover within experimental area at time point i.

3. Two sample t-test, ANCOVA (analysis of covariance), and summary statistics will be used to examine the changes between project and reference areas. T-test will be used to test the means of vegetative coverage between the two areas given any time point. ANCOVA which includes time as covariable will be used to estimate overall changes for the two areas. Ancillary data (i.e. herbivory, historical) when available will be used to aid in interpretation of results.

Goal: Increase abundance of existing vegetation.

Hypothesis:

H_0: Vegetation abundance within the experimental area at time point j will not be more than vegetative abundance at time point i.

H_a: Vegetation abundance within the experimental area at time point j will be more than vegetative abundance at time point i.

Hypothesis:

H_0: Vegetative abundance within the experimental area at time point i will not be more than vegetative abundance within the reference area at time point i.

H_a: Vegetative abundance within the experimental area at time point i will be more than vegetative abundance within the reference area at time point i.

4. Two sample t-test, ANCOVA (analysis of covariance), and summary statistics will be used to examine the changes between project and reference areas. T-test will be used to test the means of water level between the two areas given any time point. ANCOVA which includes time as covariable will be used to estimate overall changes for the two areas. Ancillary data (i.e. herbivory, historical) when available will be used to aid in interpretation of results.

   Goal: Decrease water-level fluctuations.

   Hypothesis:

   H_0: Water levels within the experimental area at time point i will not be significantly lower than water levels in the reference area at timepoint i.

   H_a: Water levels within the experimental area at time point i will be significantly lower than water levels in the reference area at time point i.

5. The primary method of analyses for salinities will be to determine differences in mean salinities as evaluated by an ANOVA that will consider *both* spatial and temporal variation and interaction. The ANOVA approach may include terms in the model to adjust for station locations, proximity to structures, and seasonal fluctuations. Ancillary data (i.e. precipitation, historical) will be used when available. This additional information may be evaluated through analyses such as: correlation, trend, multiple comparisons, and interval estimation.

   A. *Goal:* Decrease mean salinities.

   Hypothesis:

   H_0: Mean salinities within the experimental area at time point i will not be significantly lower than mean salinities in the reference area at time point i.

   H_a: Mean salinities within the experimental area at time point i will be significantly lower than mean salinities in the reference area at time point i.

   B. *Goal:* Decrease salinity fluctuations.

   Hypothesis:

   H_0: Salinity fluctuations within the experimental area at time point i will not be significantly lower than salinity fluctuations in the reference area at time point i.

H_a: Salinity fluctuations within the experimental area at time point i will be

significantly lower than salinity fluctuations in the reference area at time point i.

7. *Goal:* Increase sediment accretion rate.

Hypothesis:

H_0: The sediment accretion rate within the experimental area will not be significantly higher than the sediment accretion rate in the reference area at time point i.

H_a: The sediment accretion rate within the experimental area will be significantly higher than the sediment accretion rate in the reference area at time point i.

Hypothesis:

H_0: The sediment accretion rate within the experimental area at time point j will not be significantly higher than the sediment accretion rate in the experimental area at time point i.

H_a: The sediment accretion rate within the experimental area at time point j will be significantly higher than the sediment accretion rate in the experimental area at time point i.

8. The primary approach will be to determine differences in fisheries as evaluated by an ANOVA that will consider both spatial and temporal variation and interaction. The ANOVA approach may include terms in the model to adjust for station/transect locations, proximity to structures, and seasonal fluctuations. Ancillary data (i.e. herbivory, historical) will be used when available. This additional information may be evaluated through analyses such as: correlation, trend, multiple comparisons, and interval estimation. If the null hypothesis is rejected, both positive and negative effects will be examined.

Each aspect of the fisheries monitoring will be evaluated separately including biomass, density of organisms, and species richness.

Goal: Maintain fisheries abundance. Fisheries abundance will be measured through biomass, density of organisms and species richness.

Hypothesis:

H_0: Fisheries abundance within the experimental area will be equal to fisheries abundance in the reference area at time point i.

H_a: Fisheries abundance within the experimental area will not be equal to fisheries abundance in the reference area at time point i.

NOTE: Available ecological data, including both descriptive and quantitative data, will be evaluated in concert with the statistical analysis to aid in determination of overall project success. This includes ancillary data collected in the monitoring project but not used directly in statistical analysis, as well as data available from other sources (USACE, USFWS, DNR, LSU, etc.).

<u>Notes</u>

1.	Implementation:	Start Construction:	January 1, 1996
		End Construction:	May 1, 1996
2.	NRCS Point of Contact	Gary Eldridge	(318) 473-7694
	NRCS Vegetation	Cindy Steyer	(504) 389-0334
3.	DNR Project Manager:	Garrett Broussard	(318) 893-8763
	DNR Monitoring Manager	Dona Weifenbach	(318) 893-2085
	DNR DAS Assistant:	Mary Horton	(504) 342-4122
4.	FINA Contact:	Scott Rosteet	(318) 569-2419

5. The twenty year monitoring plan development and implementation budget for this project is $1,372,544. Progress reports will be available in November 1996, May 1997, May 1998, May 2000, May 2001, May 2003, May 2004, May 2006, May 2007, May 2009, May 2010, May 2012, and May 2013, and comprehensive reports will be available in May 1999, May 2002, May 2005, May 2008, May 2011, and May 2016. These reports will describe the status and effectiveness of the project.

6. Alternative 3A of the Project Plan Environmental Assessment was chosen.

7. Gates and weir operation shall be performed by FINA management personnel.

8. Maintenance is responsibility of Natural Resource Conservation Service.

9. Salinity and water levels have been collected starting October of 1994 to obtain pre-construction data.

10. References:

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